REMARKS

Claims 1, 20 and 28 are amended; claims 2-9, 16-19, 21-27, 29, 30, 32 and 34-86 are cancelled; and claims 1, 12-15, 20 and 28 are pending in the application. Claims 10, 11, 31 and 33 are withdrawn from consideration as pertaining to a non-elected species, but remain pending in the application in the event that claims 1 and 20, from such claims depend, are found allowable.

The pending claims stand rejected over Lee I (US 2004/0238872), either alone or in combination with Lee II (US 7,151,039) and Yamamoto (US 6,936,901).

Claims 1 and 20 are amended to clarify distinctions between the recited subject matter and that of the cited references. The remaining claims depend from claims 1 and 20, and accordingly, the amendments to claims 1 and 20 are believed to place all of the pending claims in condition for allowance.

Referring to claim 1, such recites a method of forming a material over a substrate which utilizes at least one iteration of an ALD-type pulse sequence of M_1-M_2-R, where M_1 is a metal-containing precursor comprising a first metal, M_2 is a second metal-containing precursor comprising a second metal different from the first metal, and R is a reactant which reacts with one or both of the first and second metals. The claim is amended to recite that one of the first and second metals is hafnium and the other is aluminum; and further that one of the first and second metal-containing precursors comprises tetrakis-methylethylamido hafnium (TMEAH) or tetrakis-dimethylamido hafnium (TDMEH), and that the other of the first and second metal-containing precursors comprises trimethyl aluminum (TMA).

Conventional ALD to form a composition comprising both aluminum and hafnium would comprise stacking of aluminum-containing compositions and hafnium-containing compositions over one another. For instance, traditional ALD of a mixture of aluminum oxide and hafnium oxide would comprise exposure of a substrate to either hafnium-containing precursor or aluminum-containing precursor, to form a monolayer, followed by exposure of the monolayer to oxygen to form a first oxide corresponding to either aluminum oxide or hafnium oxide. Subsequently, a second oxide would be formed over the first oxide. If the first oxide is aluminum oxide, then the second oxide can be hafnium oxide to form the mixture of aluminum oxide and hafnium oxide. The hafnium oxide would be formed by exposing the aluminum oxide to a hafnium-containing precursor, to form a monolayer; followed by exposure of the hafnium-containing monolayer to oxygen to form hafnium oxide. This conventional process is the only process referred to in Lee II (see, for example, column 13, lines 34-40 of Lee II), and Yamamoto (see, for example, column 9, lines 2-34 through column 10, lines 34 of Yamamoto).

In contrast, the invention of claim 1 is a process in which two different metal-containing precursors are formed over a substrate in an ALD-type pulse sequence prior to introduction of a reactant. The two precursors are an aluminum-containing precursor which comprises trimethyl aluminum, and a hafnium-containing precursor which comprises either tetrakis-methylethylamido hafnium or tetrakis-dimethylamido hafnium. The subject matter of claim 1 is thus quite different from the subject matter disclosed in Lee II or Yamamoto in that claim 1 recites a process in which two different precursors are sequentially flowed into a reaction chamber prior to introduction of reactant into the chamber.

However, the differences discussed above regarding the distinction of claim 1 relative to the cited references of Lee II and Yamamoto do not apply to the primary cited reference of Lee I. Lee I, like claim1, recites a process in which two different precursors are introduced into a reaction chamber prior to introduction of reactant into the chamber, during an ALD-type pulse sequence (see, for example, paragraphs 0043 and 0044 of Lee I). Lee I recognizes that the subject matter disclosed therein is different than that of conventional ALD-type processes (specifically, the processes of Lee II and Yamamoto), and indicates in the background section that conventional processes would utilize multi-layered structures of aluminum oxide films and hafnium oxide films (see, for example, paragraph 0006 of Lee I). Lee I is specific that the reason that the new process presented therein works is because one of the two precursors introduced into reaction chamber has a hydrocarbon, and the other of the precursors has a ligand with high electronegativity, such as chlorine for fluorine (and specifically Lee I discloses that a suitable precursor with a high electronegativity ligand can be hafnium tetrachloride), as discussed in, for example, paragraph 0043 – paragraph 0045 of Lee I, and as shown in Fig. 7 of Lee I.

Although Lee I is similar to the recited method of claim 1 in describing an ALD-type process in which two precursors are sequentially introduced into a reaction chamber prior to introduction of reactant into the chamber, Lee I does not disclose or suggest the subject matter of claim 1 for at least the reason that Lee I teaches against such subject matter by indicating that one of the two precursors introduced into the reaction chamber should comprise a high electronegativity ligand (for instance chlorine or fluorine), when the other comprises hydrocarbon. Claim 1 specifically recites a process in which two hydrocarbon-

containing precursors are introduced into the reaction chamber prior to introduction of reactant, and thus claims the process that Lee I is specifically teaching against.

The Examiner recognizes that Lee I does not disclose the subject matter of amended claim1 in the Examiner's rejections of dependent claims 12-14, and indicates that Lee I may be combined with Lee II and Yamamoto to render such subject matter obvious.

Applicant respectfully disagrees and submits that Lee II and Yamamoto are describing conventional ALD processes which may utilize multiple organic precursors to form multi-laminate stacks of different compositions. For instance, Yamamoto teaches that hafnium oxide may be formed utilizing an organometallic hafnium precursor, and that aluminum oxide may be formed utilizing an organometallic aluminum precursor. However, Yamamoto is not disclosing or suggesting that the organometallic hafnium precursor would be mixed with the organometallic aluminum precursor prior to exposure to oxygen to form some sort of mixture of aluminum oxide and hafnium oxide. Accordingly, Yamamoto is not providing any teaching or suggestion which would contradict Lee I's teaching that the mixture of metal-containing precursors utilized in the process of Lee I is one precursor that contains a high electronegativity ligand (for instance, chlorine or fluorine) in combination with another precursor that contains hydrocarbon. Any conclusion that an organometallic precursor from Yamamoto could be substituted for the halogen-containing precursor of Lee I is ignoring the express teachings of Lee I for the purpose of the halogen-containing precursor, and accordingly is contradicting Lee I's own teachings. Accordingly, it is inappropriate to utilize Lee I and Yamamoto in combination against amended claim 1, and

for similar reasons it is inappropriate to utilize Lee I and Lee II in combination against applicant's amended claim 1.

Amended claim 1 is allowable over the cited references for the reasons expressed above, and applicant therefore requests allowance of claim 1 in the Examiner's next action.

Claims 10-15 depend from claim 1, and are therefore believed allowable for at least the reasons discussed above regarding claim 1, as well as for their own recited features which are neither shown or suggested by the cited art.

Referring next to claim 20, such claim is amended similarly to claim 1 to recite that two metallo-organic precursors are introduced into an ALD-type process prior to introduction of a reactant into the process. Claim 20 is therefore believed allowable for reasons similar to those discussed above regarding claim 1.

Claims 28, 31 and 33 depend from claim 20, and are therefore allowable for at least the reasons that claim 20 is allowable, as well as for their own recited features which are neither shown or suggested by the cited references.

Pending claims 1, 10-15, 20, 28, 31 and 33 are allowable for the reasons discussed above, and applicant therefore respectfully requests that the Examiner's next action be a Notice of Allowance formally allowing all of the pending claims.

Respectfully submitted,

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